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ABSTRACT

This study investigated teacher decision-making within a tutorial setting. The purpose of the study was to contribute to research about teacher thinking and to provide insight into the courseware design process. The teacher task was to tutor individual students (three fifth grade students per teacher) in a problem solving activity involving a computer simulation. The study examined the instructional actions taken by five experienced teachers, including when, why, and how they chose to intervene. Information sought included the student cues that were the basis for interventions, and factors which influenced decisions. Analysis strongly suggested that differences in intervention frequency among sessions for each teacher were attributable to perceptions of students' individual cognitive and affective characteristics. (CB)

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A DESCRIPTION OF TEACHER DECISION-MAKING WHILE TUTORING FIFTH GRADE STUDENTS ENGAGED IN PROBLEM SOLVING USING A COMPUTER SIMULATION

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INTRODUCTION

The role of the computer as a personal tutor is rapidly growing. Simultaneously, improvements are called for in computer-assisted learning materials. One frequently cited weakness of these materials is their inability to adjust instruction, as human teachers do, to the learning requirements of individual students (Bork, 1981).

The tutoring process is very complex, whether carried out by a human teacher or a computer. Frequent decisions must be made regarding when to modify a student's thinking, and what to say or do to promote learning. These decisions are particularly difficult when the purpose of instruction is to teach a process skill, such as problem solving.

One approach to developing more adaptive courseware is to determine elements and processes involved in teacher decision-making (Stevens & Collins, 1988). Among influencing factors that have been identified through research on teacher thinking are student behaviors, teacher beliefs about learners and teaching, and the objectives that generate a particular course of action. These findings have come from a diverse collection of studies. In order to extend the findings, efforts have been encouraged to examine the relationship between teacher thought and action within specific and limited settings (Clark & Peterson, 1986).

The present study was designed to investigate teacher decision-making within a tutorial setting for the dual purpose of contributing to research about teacher thinking, and of providing insight into the courseware design process. The teacher task was to tutor individual students in a problem solving activity involving a computer simulation. The study examined

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instructional actions taken by experienced teachers, including when, how, and why they chose to intervene. Information sought included the student cues that were the basis for interventions, instructional actions taken, stated purposes for interventions, and factors which influenced decisions.

METHOD

Stimulated recall was the research methodology used to provide information about teacher decision-making. Verbal reports from teachers were elicited based upon viewing of videotaped tutoring sessions.

Five teachers, each of whom had a minimum of three years teaching experience, participated in the study. Each worked individually with three fifth grade students who operated a computer simulation game. The object of the game was to profitably manage an imaginary lemonade stand. The simulation contained no tutorial content. For 10 "days" of stand operation, three decisions were required: how much lemonade to make, how many advertising signs to prepare, and what price to charge per glass.

In each session, the teacher's task was to help students make the greatest profits by providing the kind of assistance she judged appropriate. The videotape of each session was shown to the teacher within two hours of instruction. The tapes were stopped at each intervention point (any instance in which the teacher spoke to the student), and the teacher was asked a series of questions designed to probe her decision-making processes. The interviews were audiotaped and transcribed.

Data analysis involved two major phases and the aid of two trained research assistants. First, a coding system, based upon one developed by Fogarty, Wang, and Creek (1983) was devised to classify student cues,

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instructional actions, and teachers' objectives identified during the interviews. The specific categories within each level of classification were determined by viewing the tapes and examining the protocols. The categories were continually refined until they were judged to be explicit and mutually exclusive.

The system was then applied to the video and audiotapes to establish frequencies of particular thoughts and actions for each teacher. Coding of all fifteen tapes was carried out by one research assistant. The second assistant coded three tapes chosen at random to establish accuracy of coding. In addition to establishing frequencies for each student cue, instructional action, and objective, decision-making patterns were determined by tallying frequencies of all possible permutations and combinations of the three elements.

In the second phase of data analysis, the interview protocols were examined to determine which factors seemed to influence teachers' decisions. Some of the factors were derived from previous studies; others emerged from the protocols.

RESULTS

1. Each teacher carried out a different number of interventions across the three sessions she conducted. The mean frequency of interventions among four of the five teachers across sessions ranged from 20 to 26; the mean for the fifth teacher was 13 interventions.

2. Each teacher reported a variety of student cues for each session. However, the same cue, general student behavior, was cited more often by each teacher than any other as the basis for the decision to intervene.

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Table

Percentage Use of Three Most Frequently Cited Student Cues, Instructional Actions, and Objectives Across Teachers Over Three Sessions

	#1	#2	#3
S.C.	Cue is from general behavior (45%)	Student is perceived to have ability to carry out a particular process (18%)	Student is perceived not to have ability to carry out a particular process (9%)
I.A.	Teacher questions student (38%)	Teacher praises (20%)	Teacher paraphrases or clarifies instructions (9%)
Obj.	To motivate or involve student (23%)	To encourage inferring, deducing, or drawing of conclusions (22%)	To supply information needed for improved decision-making (18%)

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This cue was defined as follows:

> Teacher reports that behavior of this particular student was not a catalyst for intervention; rather she would have behaved similarly with "all students" in a similar situation.

The other most frequently cited cues reflected concern for student ability. These included perceptions of ability to carry out a particular cognitive process, and assessments of student understanding of the goal of the game. The table below contains contains summary data representing the three most frequently cited student cues.

3. Different instructional actions were taken by each teacher in each session. However, the same instructional action, questioning the student, was carried out by each teacher more than any other. The table below contains summary data representing the three most frequently used instructional actions.

4. A variety of objectives was reported by each teacher; no objective was dominant for all teachers. The most frequently cited objectives included: providing students with information needed for improved decision-making, motivating or involving students, and encouraging students to infer, deduce, or draw conclusions. The table below contains summary data representing the three most frequently cited objectives.

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5. No teacher carried out the same number or type of intervention patterns per session. However, the general student cue combined with questioning was the dominant student cue/instructional action pattern for four of the five teachers, and accounted for 24% of all interventions. Each teacher used the questioning strategy to achieve two objectives: to encourage inferring, deducing, or drawing of conclusions, and to check student understanding. A total of 18% of all interventions involved one of these two patterns. These decision-making patterns are represented in the figure below.

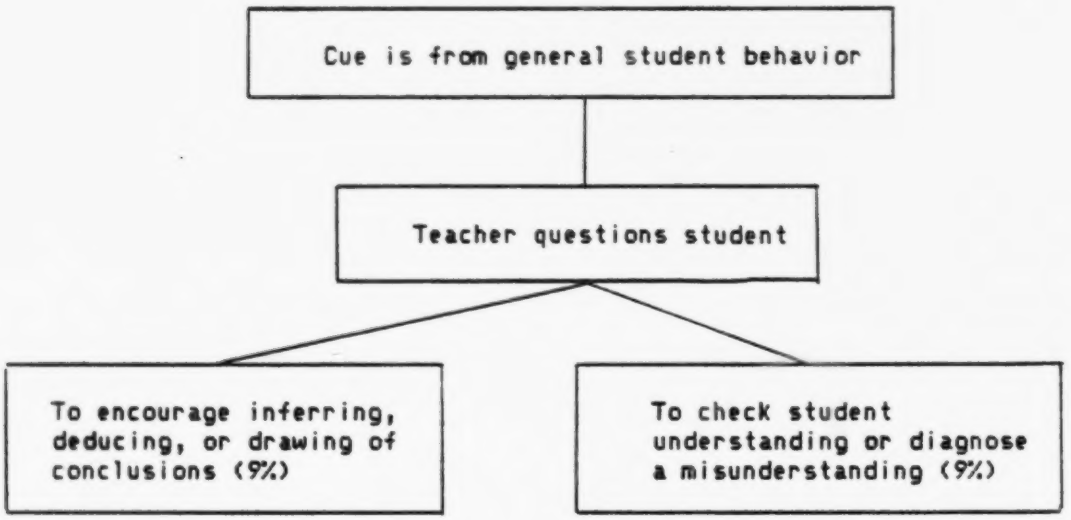
Cue is from general student behavior
Teacher questions student
To encourage inferring, deducing, or drawing of conclusions (9%)
To check student understanding or diagnose a misunderstanding (9%)

Figure: Dominant Decision-Making Pattern Across All Teachers

6. Three primary factors were identified as influencing teacher decision-making within the context of this study: 1) general beliefs about teaching and learning, 2) perception of the teachers' role in this setting, and, 3) perception of students' cognitive and affective characteristics. These factors were noted across all sessions for all teachers. Three secondary factors were also identified: 1) student

feedback, 2) feelings of self-efficacy, and 3) reflection and self-evaluation. Each factor was in evidence for some teachers in some sessions.

DISCUSSION

Evidence from the content analysis was combined with frequency data to help explain the content of teachers' decisions. Similarities and differences among teachers were found for both the number and nature of decisions.

The content analysis strongly suggests that differences in intervention frequency among sessions for each teacher were attributable to perceptions of students' individual cognitive and affective characteristics. This view rests upon the finding that teachers' general beliefs and views of the task remained essentially constant over the three sessions, whereas perceptions of student characteristics varied with each session.

As a group, four of the five teachers differed only slightly in the mean number of interventions conducted across the three sessions. The content analysis indicates that these teachers had convergent views of their tutoring role, and that these views were strikingly different than those of the fifth teacher who intervened far less frequently.

The frequent citation of general student behavior as the precipitator of interventions, as contrasted with specific student behavior, suggests that teachers were acting upon stored knowledge composed of prior student images and pre-determined expectations. The degree to which each teacher's view of this "hypothetical student" coincided cannot be assessed directly from the data, and remains a question requiring further research.

The second most frequently reported student cue for each teacher reflected the perception that the student was not succeeding at some aspect of the game. This finding again indicates that each teacher approached the tutoring task with internalized performance standards for students, and that decision-making was influenced by them.

The high percentage of questioning activity by all teachers indicates that they approached the tutoring task with similar beliefs concerning how best to develop student problem solving skills. The content analysis supports this hypothesis, as each teacher defined her role primarily as a facilitator or guide.

The dominant general student cue/questioning pattern provides evidence that four of the five teachers were carrying out a "routine." This concept, proposed by Shavelson and Stern (1981), established a model of decision-making in which plans are executed similar to a computer subroutine. Decision-making is precipitated when a teaching routine is not progressing as expected. The model presumes that routines serve the purpose of minimizing conscious decision-making. A routine is interrupted when student cues exceed tolerable limits. At this point, the teacher may need to take action based upon another routine developed from past experience. Reference in the model to intolerable cues may help explain the finding that the second most frequently reported student cues were those indicating that the student was not succeeding at some aspect of the game.

A second strong decision-making pattern revealed that teachers asked questions to achieve two objectives: to encourage the student to think deductively and to determine student understanding. The degree to which these combinations effectively promoted problem solving is an important research question that bears directly upon the development of

instructional strategies for inclusion in computer assisted learning materials.

Despite efforts to employ stimulated recall technique in its most agreed upon form, (Shavelson, Webb, & Burstein, 1986) a number of problems arose during data collection. The first problem involved the use of structured probe questions to elicit responses that would answer the research questions. One drawback to planned probe questions is that they are believed to constrain free recall (Ericcson and Simon, 1988). The dilemma is that without specific questions, information may be produced that is too general in nature.

In this study, the use of probe questions may have limited the amount of information revealed during some interviews. Evidence for this view is based upon the fact that information was inconsistently reported regarding the three secondary factors. An alternative explanation is that some information may have been evoked by factors other than the probe questions, such as teacher personality or desire to provide complete answers.

The second problem related to questioning procedures was efforts by teachers to provide answers for all questions. In so doing, teachers may have reported thoughts that occurred during the interview, rather than at the time of instruction. Although teachers were told before and during each interview that they were not expected to remember all thoughts, there were several instances where comments were made that suggested that current thoughts were being reported. One teacher became somewhat exasperated during an interview and said with a degree of chagrin: "Lots of times I don't know why I say something. It just comes out."

A related problem that surfaced during interviews was occasional

attempts by teachers to justify, rather than to explain their actions. Evidence of this behavior was found more in tone of voice than in the comments themselves. This situation is difficult to resolve or control because of ego involvement or other factors which may have precipitated the need to justify.

A fourth problem concerned assessing whether all decisions not to intervene were reported. Although at the beginning of each interview, and immediately after viewing the videotape, teachers were asked to report instances where they chose not to intervene, relatively few such instances were noted. Further research is needed to determine how often such decisions actually occur and what types of probes can elicit them.

The final problem noted involved assessing whether teachers considered alternative instructional actions. A probe question aimed at this process was not included. On a number of occasions comments were made that indicated that alternative actions were considered. For example, one teacher mentioned in two of the three interviews that she would have liked to have had a pencil and paper assessment of student mastery of the concepts in the simulation. Another teacher explained at least once during each interview about how she would teach this lesson in a classroom. Had a probe question about alternative actions been asked on a regular basis, it could have been useful in resolving the debate over whether teachers consciously choose between actions.

CONCLUSIONS

This study has presented findings indicating similarities and differences among teachers' decision-making processes within a limited context. A number of conclusions regarding teacher decision-making can

be drawn.

The first conclusion is that teachers' general beliefs about teaching and learning appeared to influence decision-making in numerous ways. These beliefs were represented by a construct called the "hypothetical student, who appeared to be a strong precipitator of intervention decisions. This finding supports Clark and Peterson's (1986) contention that cues from specific students in the teaching environment are not the sole antecedent to teacher decision-making.

A second conclusion is that teachers in this investigation viewed similarly the task of facilitating problem solving. Each expressed her task as a guiding process best carried out through questioning strategies frequently aimed at checking student information or encouraging reasoning. This pattern was often interrupted when student performance was judged in some way to be inadequate. This finding supports the model that portrays teacher decision-making as a "routine" (Shavelson & Stern, 1981).

Thirdly, teachers in this study appeared to vary instruction among students based upon perceptions of cognitive and affective characteristics. This result substantiates the growing body of evidence that indicates that student characteristics are a primary factor in the content and timing of teacher decision-making (Clark & Peterson, in press; Nespor et al., 1984).

Another conclusion is that this investigation supports the very small amount of research that has attempted to identify factors other than judgments of students as playing a role in the decision-making process (Clark & Peterson, 1986; Nespor et al., 1984). Additional research is needed to establish the degree to which these factors, and others not yet identified, affect the process.

Finally, with respect to stimulated recall methodology, the results of this study suggest that certain aspects of teacher thought remain irretrievable, difficult to elicit, or tend to be reported in ways that cast doubt upon their validity. Continued refinement of stimulated recall procedures are required to minimize these problems.

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